

# Iterative, Multi-Tier Management Information Modeling

Jean-Philippe (J.P.) Martin-Flatin  
jp.martin-flatin@ieee.org

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*Work in collaboration with Divesh Srivastava, AT&T Labs Research  
and Andrea Westerinen, Cisco Systems*



# Outline

- Mgmt info modeling in the IP world
- Four problems
- Analysis
- Multi-tier models
- Iterative process
- Advantages of our new modeling process
- Conclusion



# Mgmt Info Modeling in the IP World

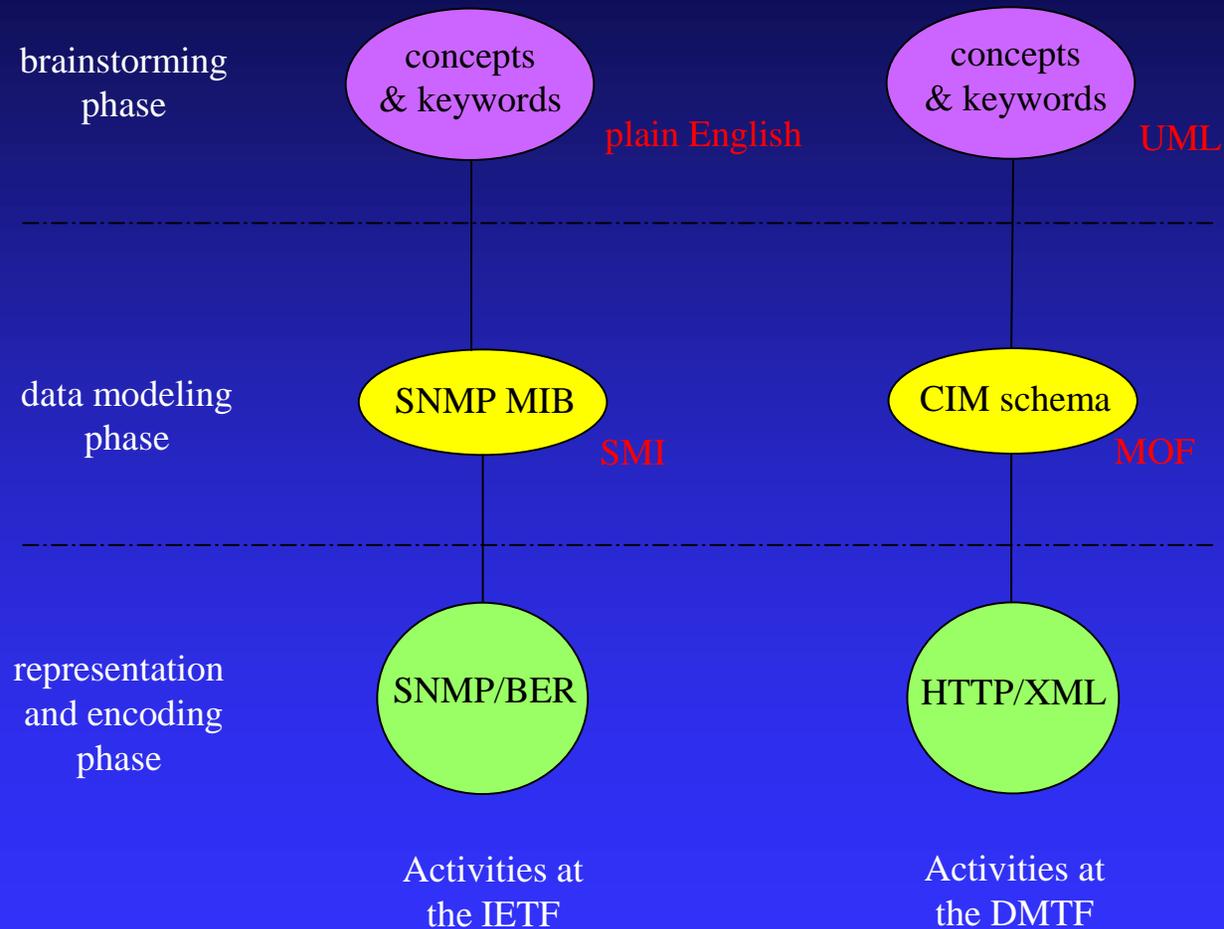


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# Technology-Independent Standardization Activities

- Metamodel:
  - ◆ DMTF: variant of UML metamodel
    - ◆ class, object, association, etc.
  - ◆ IETF: implicit metamodel
    - ◆ everything in a MIB is an OID
- Language:
  - ◆ SNMP MIBs: SMI
  - ◆ SNMP PIBs (policies): e.g., SPPI
  - ◆ CIM Schemas: MOF
- Representation and encoding of mgmt data:
  - ◆ IETF: BER
  - ◆ DMTF: XML, CIM Operations over HTTP

# Per-Technology Standardization Activities



# Four Problems



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# Some Models Are Not Good Enough (1/2)

## ■ Problem:

- ◆ Some models contain errors:
  - ◆ e.g., RFC 1156 immediately replaced with RFC 1213
- ◆ Some models miss important features:
  - ◆ e.g., no per-interface ACLs in RFC 1213
  - ◆ must use `telnet`

# Some Models Are Not Good Enough (2/2)

## ■ Causes:

- ◆ WGs are mostly driven by vendors:
  - ◆ poor trade-off between quality and timeliness
  - ◆ fast design is not beautiful...
- ◆ Management standardization efforts often fail to attract the best technology experts and the best information modelers of the world
- ◆ Fuzzy requirements:
  - ◆ e.g., what dials and knobs do we need to manage MPLS-based VPNs?



# The *Reinvent the Wheel* Antipattern

- Many standards bodies in the management arena: IETF, DMTF, OMG, TMF, ISO, ITU-T, Open Group, etc.
- Little cross-pollination between them:
  - ◆ *not invented here* syndrome
  - ◆ no time to read the literature -> start from scratch
- Consequences:
  - ◆ Terminology keeps changing:
    - ◆ e.g., DMTF: event, notification, indication
    - ◆ customers are confused
  - ◆ Standards bodies waste precious time

# Finding the Right Level of Abstraction Between Two Extremes

- Overly abstract models:
  - ◆ OMG's four-tier metamodel architecture
  - ◆ devised by theoreticians
  - ◆ over-engineering antipattern
- Overly detailed models:
  - ◆ e.g., SNMP MIBs
  - ◆ bottom line blurred by details
  - ◆ devised by management application developers
  - ◆ under-engineering antipattern

# The Learning Curve Is Too Steep

- Newcomers are swamped by the details:
  - ◆ must read SMI fluently to understand SNMP MIBs
  - ◆ must read MOF fluently to understand CIM schemas
- Newcomers need a better way to understand first the bottom line, and then the details

# Analysis



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# Four Solutions from Software Engineering (1/2)

- With one-tier MIMs, we try to do too many things at a time, and require too many skills from the same people:
  - ◆ Split between conceptual, specification, and implementation models (analysis, design, and implementation phases).
- Going from one mgmt architecture to another does not make the mgmt issues any different for a given technology:
  - ◆ Isolate the architecture-independent core from the rest:
    - ◆ facilitate reuse
    - ◆ render the design cleaner
    - ◆ decrease the risks of terminological changes

# Four Solutions from Software Engineering (2/2)

- Software quality is best assured by attracting the best people to fulfill each task throughout the software development process:
  - ◆ We need to attract the best technology experts and information modelers in standards bodies
- The waterfall process works only in simple cases:
  - ◆ As management issues become more complex, we need to migrate to an iterative and incremental modeling process.

# Constraints from Real Life

- In the IP world, mgmt systems are much more expensive today than in the mid-1990s. So, many customers now demand standards (“insurance policy”).
- Any new modeling process must allow vendors to release new technologies fast. Their market is very competitive.
- Redeploying a MIM is extremely expensive to customers and vendors. Every effort should be made to devise good models in the first place.
  - ◆ Addresses poor models, not changing requirements
- Many customers demand high-quality management applications as soon as they buy a new equipment. Large NOCs cannot afford to deploy now and manage later.

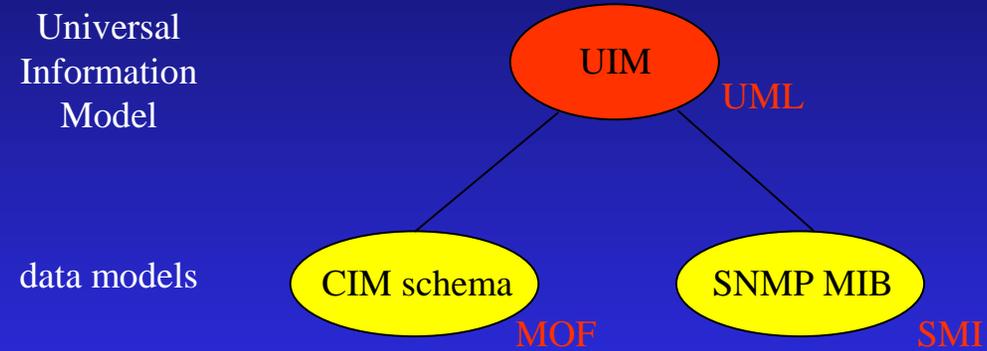


# Multi-Tier Models



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# Example: Two Tiers



# One UIM per Technology (1/2)

- UIM = object-oriented abstract model
- Independent of management architecture:
  - ◆ indep. of data repository
  - ◆ indep. of communication protocol
  - ◆ communication and information models are independent
- Durable:
  - ◆ stable terminology
  - ◆ no need to retrain people



## One UIM per Technology (2/2)

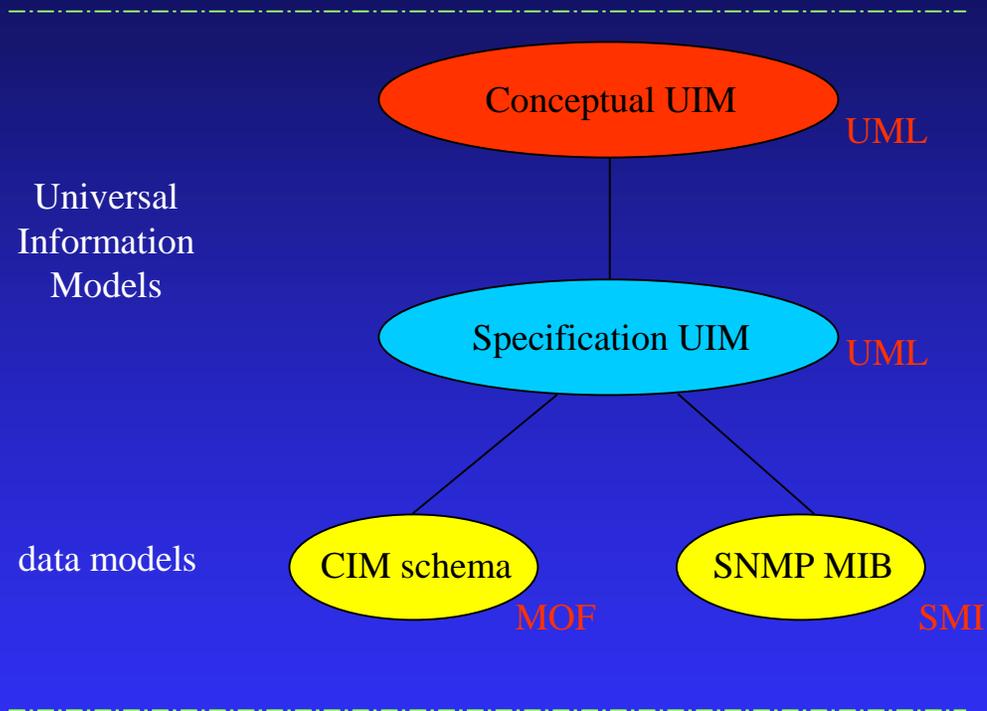
- Reusable:
  - ◆ shared by IETF, DMTF, etc.
- Expressed in UML + whitepapers
- Goal: convey the big picture to humans, not machines or compilers. Ignore details.
- Uses OMG's UML metamodel
- Devised by joint IETF/DMTF WGs:
  - ◆ researchers, independent consultants, end users
  - ◆ best technology experts, best mgmt info. modelers

# Multiple Data Models per Technology

- Several data models derived from a single UIM:
  - ◆ SNMP MIB
  - ◆ CIM schema
  - ◆ LDAP directory schema
- Not necessarily object oriented
- Language for devising data model: not prescribed
- Devised by separate WGs:
  - ◆ vendors developing mgmt applications



# More than Two Tiers



# Iterative Process



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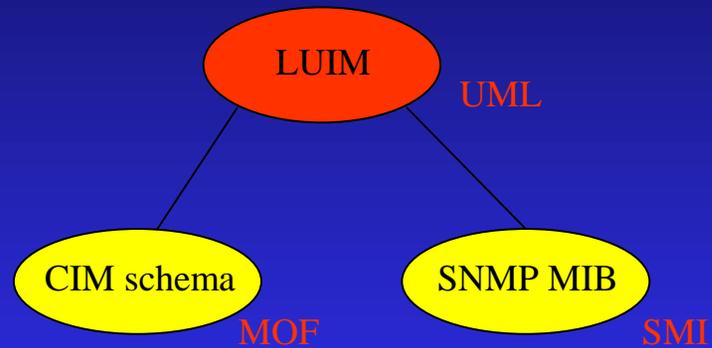
# Why Do We Need Multiple Iterations?

- N-tier models + 1 iteration = long standardization time
  - ◆ delays time-to-market for new technologies
  - ◆ vendors = no-no
- Whatever the experience of model designers, they will always get it wrong the first time they model a complex technology
- Requirements may change over time

# Iteration 1: Prototyping

Lightweight  
Universal  
Information  
Model

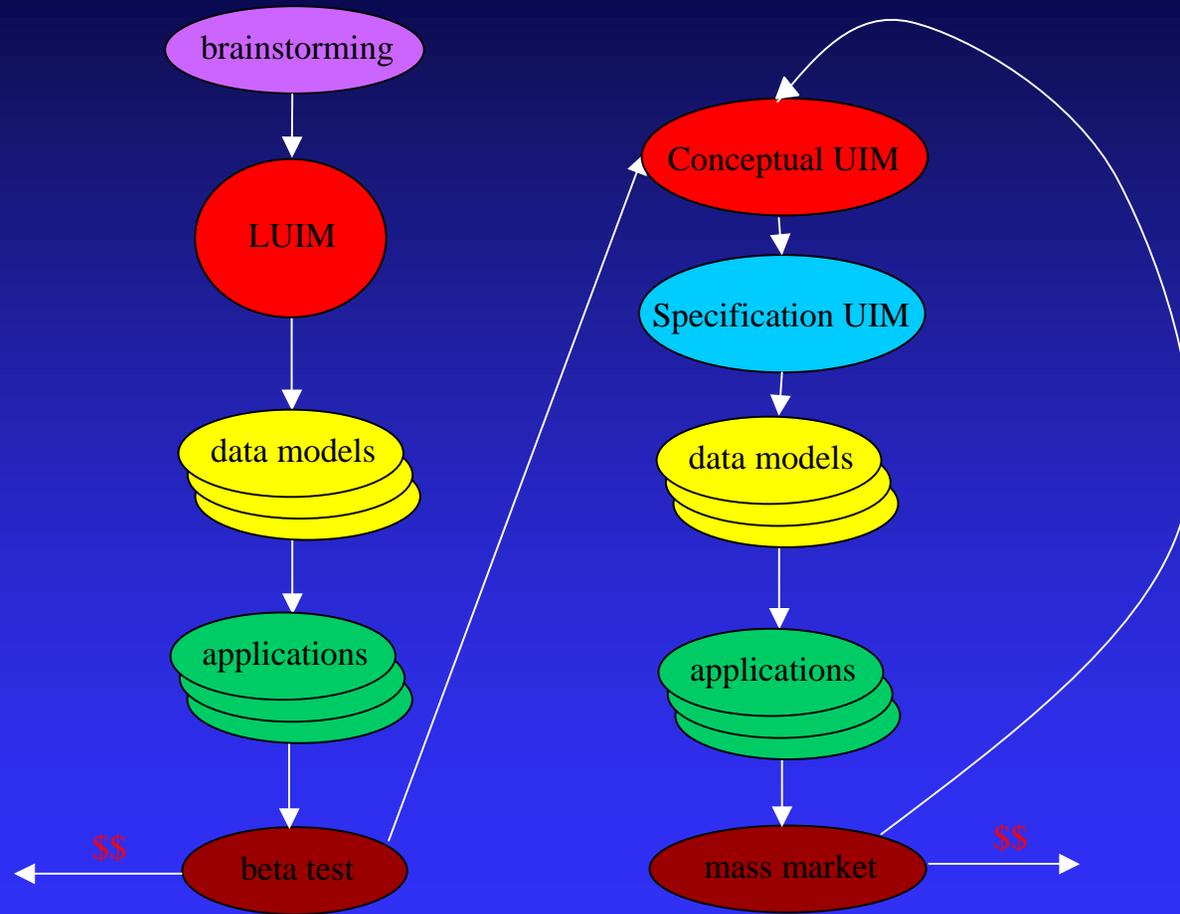
data model



# Iteration 2: Refinement

- Formalize the UIM:
  - ◆ UML class diagrams, sequence diagrams, etc.
  - ◆ whitepaper
- Improve the UIM:
  - ◆ ready for mass-market
- Make the UIM robust and durable
- Learn from the mistakes made in iteration 1:
  - ◆ feedback from beta-testers
- Formalize the lessons learned in writing:
  - ◆ e.g., annotations to the whitepaper
  - ◆ goal: the same problems will not resurface in the future

# Iterative and Incremental Process



Iteration 1

Iteration 2



# Further Iterations

- Maintenance:
  - ◆ mgmt issues changed over time
- Refinement:
  - ◆ a flaw was discovered in the info. model

# Managing Time: A Condition for Success

- Must manage time strictly
- How?
  - ◆ set deadlines for each step of the standardization process
  - ◆ chairperson of each WG must enforce deadlines
- Why would people bother to meet these deadlines?
  - ◆ competition between standards bodies
  - ◆ competition between top-notch model designers
  - ◆ recognition by the peers

# Advantages of Our New Modeling Process



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# Some Models Are Not Good Enough: Solved

- We devise multi-tier MIMs, step by step, instead of jumping directly to data models
- With the prototyping phase, we learn from experience gathered in the field
- With UIMs, standardization efforts are a lot more attractive to the best worldwide technology experts and info. modelers

# The *Reinvent the Wheel* Antipattern: Solved

- For a given technology, all data models are derived from a single UIM
- Build on past experience:
  - ◆ reuse
- Stable terminology

# Finding the Right Level of Abstraction Between Two Extremes: Solved

- With multi-tier models, we allow info. modelers to capture different things:
  - ◆ UIM: big picture
  - ◆ data models: details
- When the mgmt issues for a given technology are complex, we can have as many tiers as necessary

# The Learning Curve Is Too Steep: Solved

- Conceptual models make it easier for newcomers to get started with the mgmt of a given technology
- Conceptual models expressed in UML (*lingua franca*) can be readily understood by people who do not know the idiosyncrasies of SNMP or WBEM

## More Advantages

- If the technology changes during prototyping, once the LUIM is devised, we still have a chance to update the UIM in iteration 2 (i.e., before large-scale deployment)
- Having UIMs shared by the IETF and DMTF helps vendors cut their mgmt software development cost when they support both SNMP MIBs and CIM schemas
- By imposing strict time mgmt, we put an upper bound on the time-to-market for the first iteration. This is important for marketing people.

# Dealing with Multiple Competing UIMs

- Occurs when:
  - ◆ different people in a WG have conflicting views on the way a technology should be managed
  - ◆ different WGs come up with different UIMs, which are both consistent and smart
- Problems:
  - ◆ causes terminological confusion
  - ◆ segments the market
- Solution:
  - ◆ IETF's way: let the market decide
  - ◆ customers can compare UIMs: all expressed in the same *lingua franca* (UML)

# Conclusion



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## Summary (1/2)

- We described 4 problems pertaining to mgmt info modeling in the IP world:
  - ◆ some models are not good enough
  - ◆ *reinvent the wheel* antipattern
  - ◆ finding the right level of abstraction
  - ◆ learning curve is too steep
- We proposed a new modeling and standardization process to alleviate or solve these problems:
  - ◆ multi-tier models
  - ◆ iterative process

## Summary (2/2)

- We advocated the cooperation between standards bodies (esp. IETF & DMTF)
  - ◆ they share conceptual UIMs
- We advocated multi-specialization:
  - ◆ *UIMs*: designers
  - ◆ *data models*: specialists of SMI (SNMP), MOF (WBEM/CIM), etc.

# Directions for Future Work

- Define conceptual UIMs:
  - ◆ Some work underway at AT&T and Cisco
  - ◆ Reverse-engineer SNMP MIBs
  - ◆ Reverse-engineer CIM schemas
- Several data models are derived from a single UIM. Does it facilitate the translation between these data models?
- Do UIMs require an equiv. to DMTF's Core Model?